1 Overview

Welcome to CS 134. In this lecture we will give a high level overview of the course, and discuss some of the logistics.

2 Basic information

Course staff:

- **Professor Yaron Singer**
  Office hours: Wednesdays 4 – 5pm, Maxwell Dworkin, room 239.
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- **Alex Wang**
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- **Jason Goodman**
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Location and schedule: We will meet on **Mondays and Wednesdays 2:30 − 4:00pm**, in **Jefferson Lab, Room 250**. Meeting times are Harvard times (seven minutes past the scheduled time), and will try to accommodate those coming from afar.

Course homepage: Most information about the course can be found on the course homepage:

http://harvardcs134.com

3   Prerequisites and Diagnostics

To enjoy and succeed in this course, you will need to be comfortable with some basic math and programming, as well as with some essential ideas from economics.

1. *Math*: calculus at the level of Math 1. Basic probability at the level of easily getting a 5 on the AP Statistics exam (definitions and basic properties of distributions, expectation, variance);

2. *Programming*: CS50 taken previously or concurrently, or you should have equivalent programming ability. Programming assignments will be part of the homework, and you will be expected to get help on basic coding outside the class if you need it;

3. *Economics*: optimal choice in the presence of randomness; notion of a utility function; definition and basic use of expected utility; maximizing a social welfare function subject to constraint.

We have prepared diagnostic quizzes that are available, along with their solutions, on the course webpage:

`http://harvardcs134.com`

These are purely for your private use. For any of these subjects that you do not feel completely comfortable with, take the diagnostic and *write out the answers*. Then check against the solutions that are up on the web. You should, of course, feel free to discuss the quizzes with the TF's.

If you find that you cannot easily solve all the diagnostic problems correctly, the solutions contain references to resources online that you can use to get up to speed.

4   Logistics

Lectures:

- Laptop policy: We strongly discourage the use of laptops and other electronic devices such as phones in class. For most of you, the best way to spend the lecture is listening to and thinking about the material, jotting things down occasionally (key facts and formulas will appear in the published lecture notes later).

  You are adults and we will let you make your own decisions on this. However, we will require you to commit to whether you want to leave yourself the option of using laptops and smartphones.

  - If you decide that you *do* want access to your devices, you will sit in the *devices-allowed* section.
  - If you decide that you do *not* want access to your devices, you will sit in the *no-devices-allowed* section, and the TF's will enforce the policy in that section.

  Please make your decision by the start of the lecture on Monday, January 30th, 2017.

• Lecture notes: lecture notes will be released after class and will summarize definitions and main ideas. In general, we strongly encourage you to attend lecture, as the lecture notes are not necessarily self-contained and do not aim to substitute for class attendance.

Problem Sets: Problem sets will *go out on Wednesday* by the end of lecture and will be due *the next Wednesday* at 11:59am. Assignments will be submitted via Canvas. Solutions will be posted very shortly after the deadline.

Sections: We will have sections on a weekly basis taught by the teaching fellows. Sections will include exercises on things we do in class, and in some cases help set up new concepts that we will learn in lectures. Sections are not mandatory, but we strongly encourage you to participate. Section times will be determined next week and **we will aim to schedule sections on Wednesday and Thursdays**.

Programming: Most problem sets will include programming assignments. The programming will be relatively light, where the idea is to use simple scripts to analyze real-world network data sets and apply some of the algorithms you learn in class. You're expected to have taken CS50 or have similar background and experience. You are expected to know how to code in Python. We will not teach Python or programming related material, but we will have weekly programming exercises in section to help you with the programming exercise in the problem set.

Exams: The learning objectives page has questions that are representative of the ones that could appear on an exam. There will not be programming questions *per se*, but there will be related questions (writing pseudocode, using insights from programming exercises completed in the course).-

• First exam: Wednesday, February 15th, in class.

• Second exam: Wednesday, April 26th, in class.

Grading: The grading for the course consists of three differently-weighted pieces:

• 5%: class participation; for Extension students participation is via Piazza (we will present open-ended questions and ask for your comments);

• 45%: weekly problem sets (two lowest scores dropped; no excused lateness) and optional writing assignment;

  – Dropping policy: for example, if there were ten problem sets and your scores are 100 (5 times), 85, 80, 70, 60, 0, then the problem set grades that *count* are 100 (5 times), 85, 80, 70.

  – If you do the writing assignment, it will replace the two lowest of the problem sets that count, assuming it helps your grade. Thus, if you get a 90 on the writing assignment in the above example, your problem set grade will be calculated as the average of 100 (5 times), 85, 90, 90.

- 20%: first exam (February 15th);
- 30%: second exam (April 26th).

Piazza: We will be using Piazza as a tool for students to ask questions about the material covered in class and about assignments. Join Piazza for this course here:

`http://piazza.com/harvard/spring2017/cs134/`

The required class code is networks. Of course, students also have the opportunity, and are encouraged, to go to office hours to ask questions.

5 Resources

Textbooks: The required textbook for the course is:

- *Networks, Crowds, and Markets: Reasoning about a Highly Connected World* by David Easley and Jon Kleinberg, Cambridge University Press, 2010. A version of the book is available for free online:

  `http://www.cs.cornell.edu/home/kleinber/networks-book/`

Recommended, though not required::

- *Social and Economic Networks* by Matthew Jackson, Princeton University Press, 2008.

The textbooks are available at the Harvard Coop under our course.

Additional resources: We will post relevant materials, such as research papers, blog posts, supplemental textbook reading, etc., on the course webpage:

`http://www.harvardcs134.com/index.php/course-resources/`

6 Course outline

Preliminaries

- Graph definitions and basic properties
- Random graphs

Small world networks

- Small-world phenomena
- The structure of small world networks
- Navigation in a small world

Structure of networks

- Power law and heavy tailed degree distributions

- Preferential attachment and the rich-get-richer model

Statistical biases in networks analysis

- The friendship paradox, or why your friends have more friends than you

- The friendship paradox in power-law networks

Strategic interactions

- Game theory definitions and basics

- Solving games: elimination of dominated strategies and Nash equilibrium

- Network games

Influence in networks

- Models of social influence in networks

Diffusion of information

- Cascading behavior in networks

- Random walks in graphs

- Influence maximization

Link analysis and web Search

- Spectral Analysis of Networks

- Pagerank, HITS algorithms

Clustering and communities in networks

- Unsupervised machine learning

- Clustering in networks

Networked markets

- Matching markets: labor markets and kidney exchanges

- Selfish routing in transportation networks, the price of anarchy, and Braess paradox

7   Action items

- **Diagnostic quiz:** If you have any doubt as to whether your background in a particular area (math, programming, economics) suffices, take the diagnostic quizzes in those subjects to see whether this course is a good fit for you:

  `http://www.harvardcs134.com/index.php/assignments/`.

- **Problem set due in one week:** The first problem set is up and due Wednesday, February 1st, 2017 at 11:59am. You can find problem sets here:

  `http://www.harvardcs134.com/index.php/assignments/`.

- **Decide laptop preference:** Look into your heart and soul and decide whether or not you will be sitting in a laptop-allowed zone or not.